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TRANSPORTATION RESEARCH COMMAND  
FORT EUSTIS, VIRGINIA

AD621893

PRELIMINARY FLIGHT TEST DATA

XH-51A RIGID ROTOR HIGH SPEED FLIGHT PROGRAM

INTERIM REPORT NO. 9

DECEMBER 1964

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TSL-121-2/65

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## SUMMARY

This report summarizes the flight test results of the Phase IV, XH-51A compound helicopter testing. For this program, an XH-51A helicopter was modified to incorporate a wing and a J-60 auxiliary jet engine. The purpose of this phase was to obtain flight test data on performance, stability, maneuverability, critical stresses and vibration at speeds up to an objective of 200 knots. The data included in this report presents the results in these areas at speeds up to a level flight true airspeed of 200 knots.

The completion of this phase represents the end of the flight testing required by the original contract. Preparation of a final report is in progress.

## Results and Discussion

### Performance

Level flight performance of the compound helicopter in terms of shaft horsepower required is shown on Figure 1. This data has been corrected to sea level standard day and shows performance as a pure helicopter, with the J-60 engine at idle and in full compound flight. Figure 2 shows the jet thrust required for the same flight condition. Figure 3 shows the tail rotor power required. Equivalent total propulsive power requirement can be seen by summing the curves shown in Figures 1, 2, and 3. Figure 4 shows the variation of rotor lift which was measured during the performance testing. Note that at the high speeds the rotor was very nearly unloaded.

### Flying Qualities

Cyclic control stick positions in trimmed level flight are shown on Figure 5. During the course of the program, the incidence of the control gyro arms was reduced from 30 degrees to 5 degrees to reduce structural loads in the gyro drive system. This resulted in a change in the aerodynamic forces which produce a gyro processing moment and an apparent shift in the static stick-fixed longitudinal stability. Actual longitudinal stability, evidenced by the pitching moment of the wing-body against the rotor system was not altered by the gyro arm incidence change.

As forward flight speed was increased, measurement of the one per rev. flapwise bending in the main rotor, resolved to show the pitching and rolling components, indicated increasingly negative longitudinal stability. To restore positive longitudinal stability, the size of the horizontal tailplane was increased. Figures 6 and 7 show the effect of the change in area of the horizontal tailplane on the pitching component of the main rotor one per revolution flapwise bending.

Tail rotor pedal position is shown in figure 8 and indicates that ample directional control margins existed at high speed.

Maneuvering stability was comfortably positive throughout the test program. This is shown on Figure 9.

### Structures;

Structural measurements including loads in the main rotor hub and blades, control gyro arms, main rotor pitch link, tail rotor, horizontal stabilizer, wing bending, and main rotor lift were obtained. A review of the loads measured indicates that the major structural item most likely to govern the fatigue life of the vehicle is the main rotor hub at station 7.0. Hub flapwise and chordwise bending moments were measured at hub station 6. These station 6 bending moments can be converted to stress at station 7 by the following factors.

Station 6 flapwise bending moment, inch pounds X  
1.42 = station 7 stress, psi

Station 6 chordwise bending moment, inch pounds X  
0.152 = station 7 stress, psi

Assuming a stress concentration factor of 3, the hub at station 7 has an estimated endurance limit cyclic stress of 26,000 psi.

The compound helicopter was initially flown without the auxiliary J-60 jet engine operating. These tests were conducted from hover to a forward speed of 96 knots CAS. The structural loads with the J-60 off are shown in Figures 10 and 11. The structural loads on these plots are essentially the same as the conventional XH-51A helicopter loads extrapolated to the weight and C.G. of the compound helicopter.

The next series of tests were conducted with the J-60 at idle (approximately 200 pounds of thrust). The structural loads with the J-60 at idle are shown in Figures 10 and 12. These plots show that the main rotor hub loads decrease with the added thrust from the J-60 at idle. With increased J-60 thrust for level flight, tests were conducted to determine the optimum collective blade angle setting for the higher speeds. The structural loads are plotted versus collective blade angle for the various speeds and collective blade settings up to 158 knots CAS, Figures 13, 14, and 15. From these tests, the optimum collective blade angle setting from a blade loads standpoint was determined to be approximately 4.5 degrees. The main rotor hub loads for this collective blade angle setting are also plotted versus calibrated airspeed on Figure 10.

With the large horizontal stabilizer at zero degree incidence, tests were conducted at 120 knots and 140 knots with variations in collective to determine the effect of collective blade angle setting. The data from these tests are plotted in Figures 16, 17, and 18. Extrapolation of these data to the higher speed conditions indicated that a collective setting around 3.8 degrees would be a satisfactory compromise angle for proceeding to high speeds with a constant collective blade angle.

The speed was built up to 201.5 knots CAS in approximately 10 knot increments with the collective blade angle held at approximately 3.8 degrees. The data from these tests are plotted versus airspeed in Figures 19 through 23.

The main rotor blade flapwise cyclic bending at station 6 shown in Figure 19 increased almost linearly with speed to a maximum value of 15,300 inch pounds at 201.5 knots. As can be seen in Figure 23, the majority of this moment was caused by the one per revolution pitch and roll components of the blade bending.

The cyclic flapwise bending at station 6 of 15,300 inch pounds converts to a cyclic stress of 21,700 psi at station 7. The cyclic chordwise moment at station 6 of 18,200 inch pounds converts to a stress of 2,800 psi at station 7. The sum of the two results in a maximum possible cyclic stress of 24,500 psi as compared to an estimated endurance limit of 26,000 psi.

Main rotor pitch link axial loads are shown in Figure 21. The maximum cyclic loads are only 137 pounds as compared to an estimated endurance limit of 1,400 pounds. Note that there has been no tendency for the loads to increase rapidly with speed increase. The blade feathering and torsion loads have increased only very gradually with increase in airspeed.

Gyro arm flap and chord bending loads also are shown in Figure 21. At speeds above 170 knots, the gyro arm incidence angle setting was reduced from 30 degrees to 5 degrees. This had negligible effect on the cyclic chordwise loads, but did reduce the cyclic flapwise loads. The incidence angle was changed to reduce the steady torsion load on the gyro drive shaft. The cyclic loads measured are well below the estimated endurance limit of the gyro arms.

Measurements of tail rotor flapwise bending at station 19.5 were obtained at speeds above 170 knots. These are shown in Figure 22. Analysis of data obtained during previous tests with the three-blade main rotor had shown that station 19.5 was the most critical bending station on the tail rotor. The cyclic loads fall somewhat below what might be expected by extrapolating the measurements as a regular helicopter; however, they are approaching the estimated endurance limit of 790 inch pounds. Linear extrapolation of the data indicates that the endurance limit would be reached at a speed somewhere between 230 and 240 knots CAS.

Measured horizontal stabilizer bending loads are shown in Figure 20. There is a difference between the average load L and R indicating an apparent swirl in the air flow in that area. The static loads are well under the limit static strength. The cyclic loads obtained are reasonably high and the frequency of motion is at tail rotor rotational frequency. The symmetrical first bending mode of the stabilizer, as determined by ground shake tests, is 30.5 cps. The tail rotor rotational frequency is 35 cps and apparently the two frequencies are close enough together to provide a reasonable amount of excitation to the stabilizer. To help alleviate this, cable guy wires were strung from the stabilizer tips to the fuselage top and bottom at the stabilizer. These helped keep the oscillatory amplitude from building up too rapidly. The estimated endurance

limit for the stabilizer is 3,200 inch pounds. This was exceeded by 22 per cent for a few minutes of flight time in the runs at speeds above 180 knots.

#### Autorotation Entries

Structural loads during the transition from powered flight to autorotation and during the autorotation are usually less than experienced in powered level flight and therefore are not shown.

#### Maneuvering Conditions

The load factors obtained at various airspeeds with the J-60 jet engine off are shown in Figure 24. The maximum speed obtained with jet off was 134 knots CAS and the maximum load factor was 1.51 g's with the minimum load factor of 0.4 g's. With the jet engine operating, the speed-load factor values obtained are plotted in Figure 25. The maximum load factor obtained was 1.8 g's and the minimum 0.64 g's. All load factors are corrected to a weight of 4,300 pounds.

Main rotor flapwise and chordwise bending moments at station 6 and flapwise bending moment at station 157 are plotted versus load factor in Figures 26, 27, and 28. With the jet engine on and the collective blade angle lowered, the flapwise average bending moments at station 6 are more negative due to the reduced rotor lift. The cyclic loads scatter considerably and do not appear to have any significant trend with either load factor or rotor lift. With reduced rotor lift, the chordwise loads, both average and cyclic, are reduced considerably at all load factors. At station 157, the flapwise cyclic bending loads appear to be somewhat smaller with a reduced collective blade angle (jet engine on), whereas the average loads appear to be relatively unaffected by the collective blade angle.

The flapwise and chordwise cyclic loads are the maximum loads that occurred during the maneuver and do not necessarily occur at the time of the maximum load factor.

#### Vibration

Cabin vibration levels are shown on Figure 10 for the pure helicopter mode and Figure 11 with the J-60 at idle. Due to the high gross weight and the power levels required, these vibration levels are excessive.

In compound flight, the vibration levels are greatly reduced and are shown on Figure 29 for frequencies of 4 per revolution and higher.

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3	Level Flight Performance, Variation of Tail Rotor Horsepower . . . . .
4	Level Flight Performance, Variation of Rotor Lift.
5	Cyclic Control Positions in Level Flight . . . . .
6	Pitch & Roll Component of No. 1 Flap Bending Sta- tion 6 vs. Collective Blade Angle . . . . .
7	Roll & Pitch Component vs. Collective Blade Angle.
8	Tail Rotor Pedal Position in Level Flight . . . .
9	Maneuvering Stability - J-60 Engine Operating . .
10	Main Rotor Blade Loads vs. Calibrated Airspeed . .
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15	Load vs. Collective Blade Angle . . . . .
16	Loads vs. Collective Blade Angle . . . . .
17	Main Rotor Blade Loads vs. Collective Blade Angle.

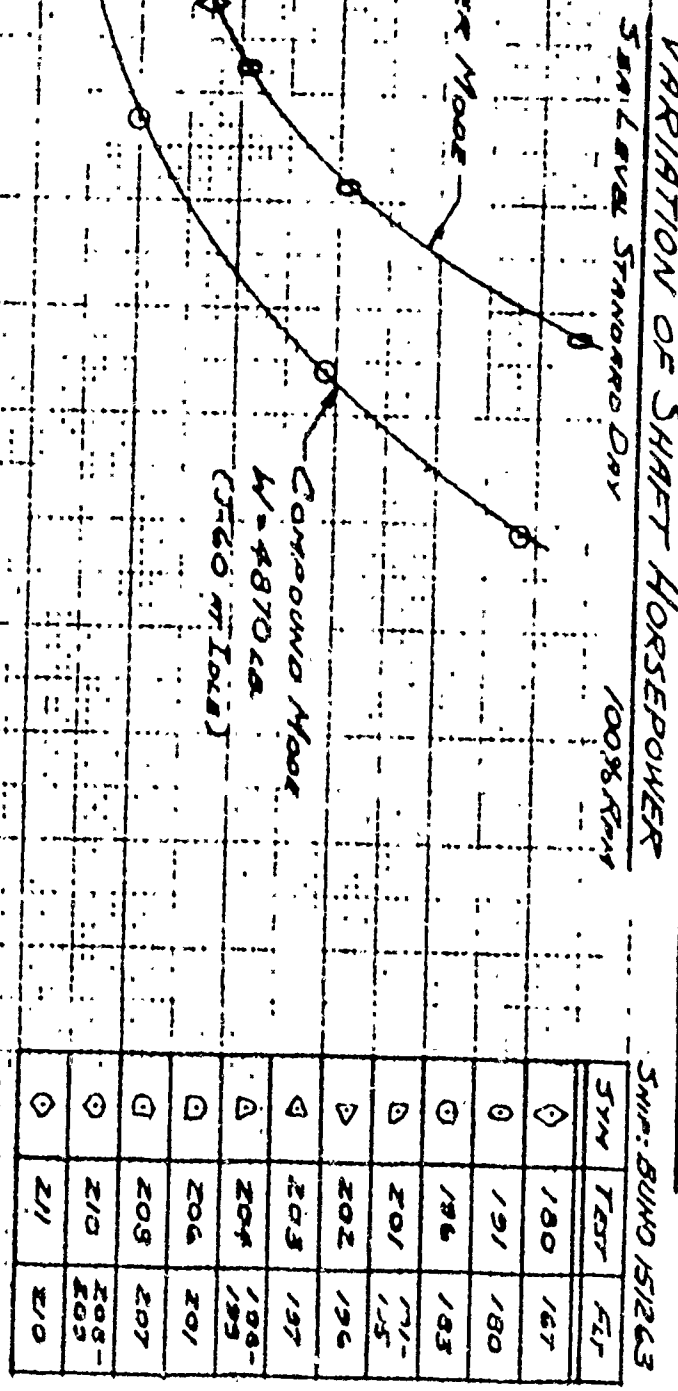
<u>Figure</u>	<u>Title</u>
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19	Main Rotor Blade Loads vs. Calibrated Airspeed .
20	Main Rotor Blade Loads vs. Calibrated Airspeed .
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# LOCKHEED HELICOPTER MODEL XH-51A

## FIGURE 1

### LEVEL FLIGHT PERFORMANCE - COMPOUND HELICOPTER



SHAFT HORSEPOWER

PURE HELICOPTER MODE  
W=4625 LB

COMPOUND MODE  
W=4870 LB  
(5760 m lbf)

COMPOUND MODE  
W=4700 LB

W=5100 LB

TEST TRUE AIRSPEED-KNOTS

(10000)

LOCHNARD HELICOPTER  
Model XH-51A

# FIGURE 3

## LEVEL FLIGHT PERFORMANCE - COMPOUND HELICOPTER

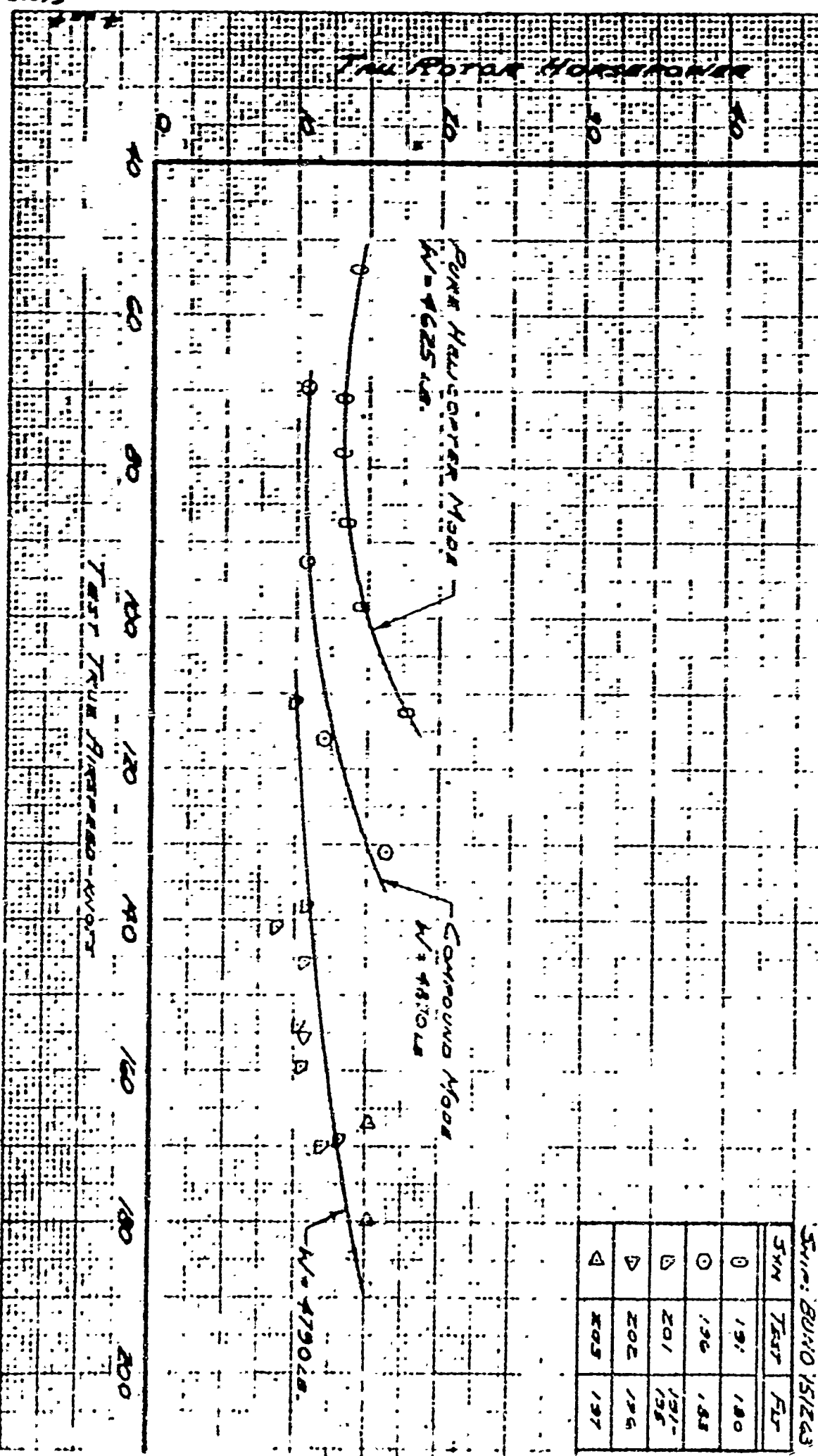
VARIATION OF THRU ROTOR HORSEPOWER

SEA LEVEL STANDARD DAY

100% RPM

SRM: BUHNO 151243

SYM	TEST	FLT
0	191	180
0	196	188
0	201	191-195
0	202	196
0	205	197



LOCKHEED HELICOPTER  
MODEL XH-51A

# FIGURE 2

## LEVEL FLIGHT PERFORMANCE - COMPOUND HELICOPTER

### VARIATION OF NET THRUST

SEA LEVEL STANDARD DAY 1400 RPM

#### STANDARD VALUES

SYM	TEST	FLY
1	104	100
2	101	101
3	102	102
4	103	103
5	104	104
6	105	105
7	106	106
8	107	107
9	108	108
10	109	109
11	110	110
12	111	111
13	112	112
14	113	113
15	114	114
16	115	115
17	116	116
18	117	117
19	118	118
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21	120	120
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401	500	500
402	501	501
403	502	502
404	50	

LOCKHEED HELICOPTER  
MODEL XH-51A

FIGURE 4

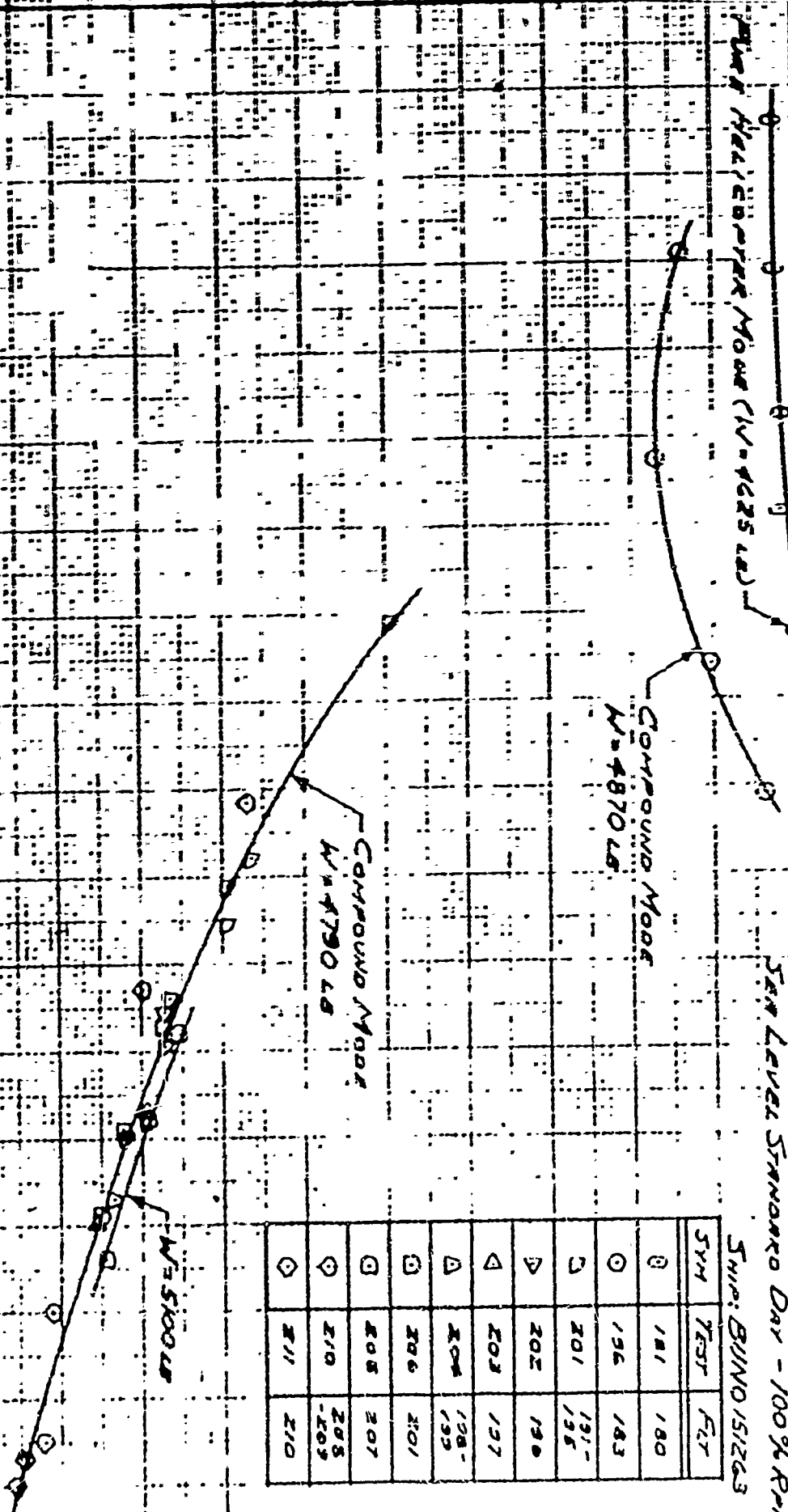
# LEVEL FLIGHT PERFORMANCE - COMPOUND HELICOPTER

VARIATION OF ROTOR LIFT

SEA LEVEL STANDARD DAY - 100% RPM

TYPE: BUINO 151263

SYM	TEST	FLY
0	181	180
1	196	183
2	201	191 - 196
3	202	198
4	203	197
5	204	198 - 199
6	206	201
7	208	207
8	210	205 - 209
9	211	210



TEST TRUE AIRSPEED - KNOTS

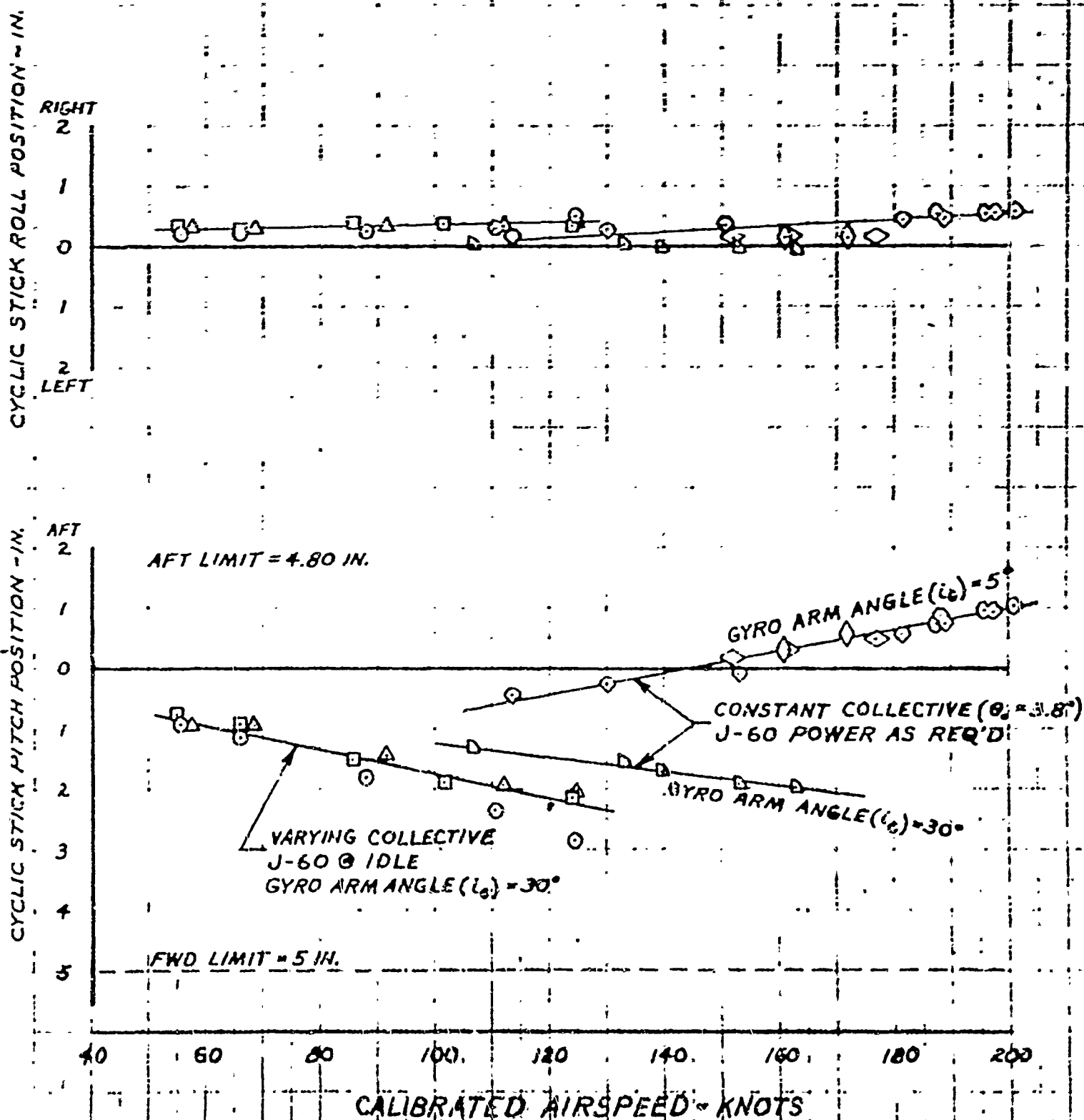
LOCKHEED HELICOPTER  
MODEL XH-51A  
SHIP - BUNO 151263

CYCLIC CONTROL POSITIONS IN LEVEL FLIGHT

COMPOUND HELICOPTER

FIGURE 5

SYM	○	□	△	◇	◇	◇	◇	◇
TEST	196	197	199	201	206	208	210	211



2H 51A BUNO 151263 3/41002 COMPOUND

PITCH/ROLL COMPONENT OF NO.1 FLAP BEND STA. 6 VS. COLLECTIVE BLADE ANGLE

4 BLADE ROTOR . . . 5-60 ON  
1.57. SFT. HORIZ. STAB. 0 - 10 DEG.

FIGURE 1

△ 100 K.CAS  
△ 70 K.CAS  
□ 110 K.CAS  
▽ 120 K.CAS  
○ 130 K.CAS  
◇ 150 K.CAS

PITCH COMPONENT NO.1 BLADE FLAP  
NO.1. 5 IN. 6 (PER REF)  
- IN LOS. X 1000

ROLL COMPONENT NO.1 BLADE FLAP. NO.1. STA. 6  
(PER REF) - IN LOS. X 1000

UP FWD

UP AFT

UP LT

UP RT

COLLECTIVE BLADE ANGLE DEG

IN-51A BUNO 151263 1/11 1932 COMPOUND

# ROLL & PITCH COMPONENT VS. COLLECTIVE BLADE ANGLE

4 BLADE MOTOR

24.2 50 FT. HORIZ. STAB. @ 0.0 DEG.

2-62 ON

Δ 1120H CAP

▽ 1340H CAP

FIGURE 7

NO. 1 BLADE  
UP FWD

PITCH COMPONENT OF NO. 1 BLADE

FLAP MOM. STA. C (1 PER REV)

~ IN LBS. ± 1000 ~

UP AFT

UP LT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

UP RT

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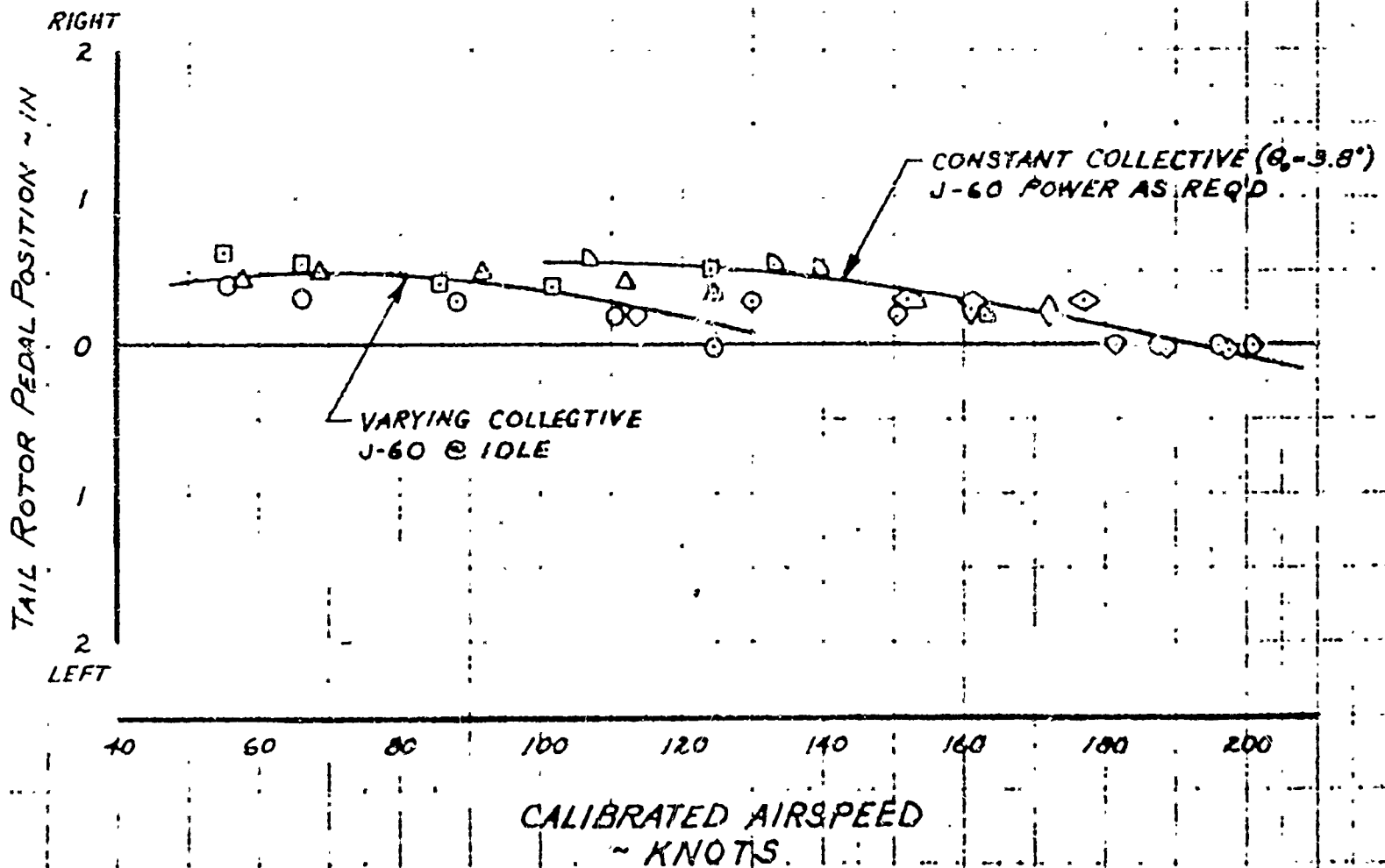
COLLECTIVE BLADE ANGLE - DEG.

LOCKHEED HELICOPTER  
MODEL XH-51A  
SHIP - BUNO 151263

TAIL ROTOR PEDAL POSITION IN LEVEL FLIGHT  
COMPOUND HELICOPTER

FIGURE 8

SYM	○	□	△	◻	◇	◊	◌	◌
TEST	196	197	199	201	206	208	210	211





# LOCKHEED HELICOPTER

Model XH-51A

## MANEUVERING STABILITY-COMPOUND HELICOPTER

J-60 ENGINE OPERATING

SHIP: BUNO 151263

FIGURE 2

SYM	TEST	FLY	WAVE -LB	DEN. ALT-FT	LONG. MOM.	LAT. MOM
○	189	178	4335	1850	-3685 W-18 FWD	-19181 W-18 LT.
□	192	181	4400	2550	-3600 FWD	-19181 LBT

### CONFIGURATION NOTES:

1. CYCLIC STICK PITCH  
SENSITIVITY = 100%
2. GYRO ARM ANGLE = 30°
3. HORIZ. TAIL INC = -1° (S = 2.57 in)
4. 31.5 LB BOB-WEIGHT  
INSTALLED (7.2 LB/g)
5. LANDING GEAR UP.
6. SPEED SENSOR OFF.
7. USING SWIVEL-HEAD  
AIRSPEED SYSTEM.

CYCLIC STICK PITCH FORCE IN LB

24

20

16

12

8

4

0

1.0

1.2

1.4

1.6

1.8

2.0

LOAD FACTOR - g's

130 KTS / 685 LB

140 KTS / 580 LB

0 = 3.8°

(100RC)

FOAM 8278

(100RC)

# MAIN ROTOR BLADE LOADS IN AIRCRAFT A-1H 4 BLADE ROTOR

7.57 SQ FT HUB L. STAB 2 - 1.0 DEG

□ - J-60 POWER OFF

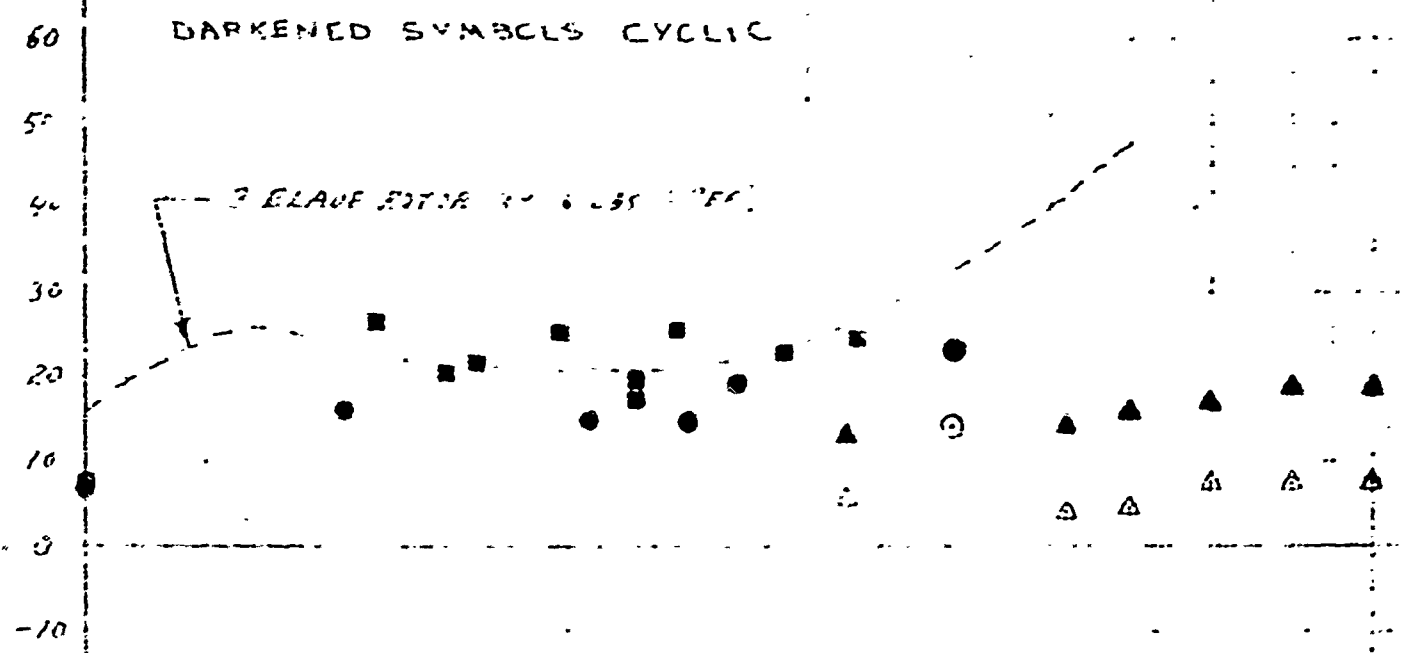
○ - " " IDLE

△ - J-60 POWER TO MAINTAIN LEVEL FLIGHT  
WITH COLLECTIVE AT OPTIMUM SETTING OF 4.5 DEG.

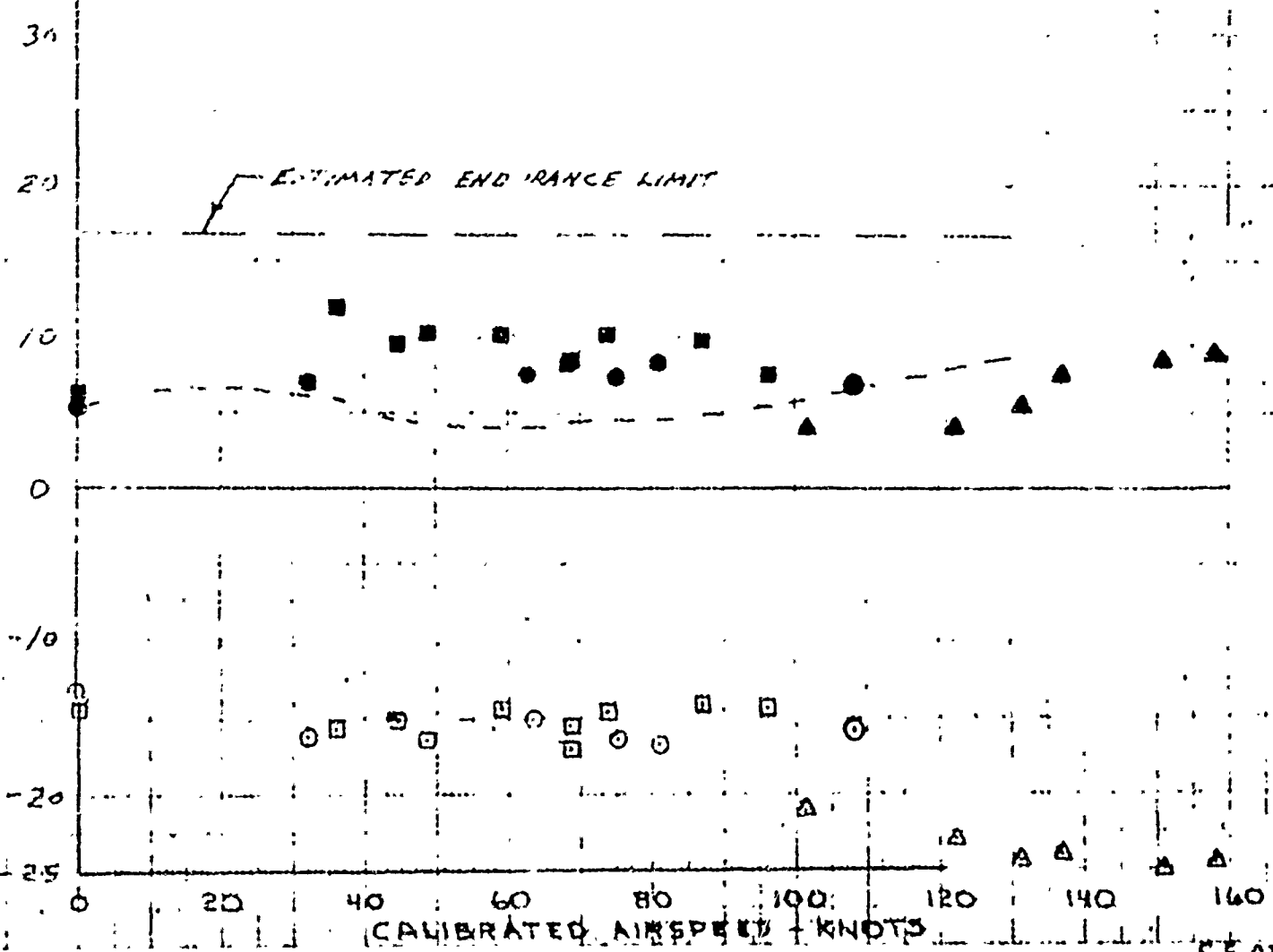
FIGURE 10

OPEN SYMBOLS - AVERAGE  
DARKENED SYMBOLS CYCLIC

CHORDWISE AIRCRAFT MOMENT STA. 1  
~ IN LBS. x 100



FLAPWISE AIRCRAFT MOMENT STA. 1  
~ IN LBS. x 100



JH 51A 1002-COMPDUYD  
 LOADS & ACCELERATIONS VS. CALIBRATED AIRSPEED  
 4 BLADE ROTOR

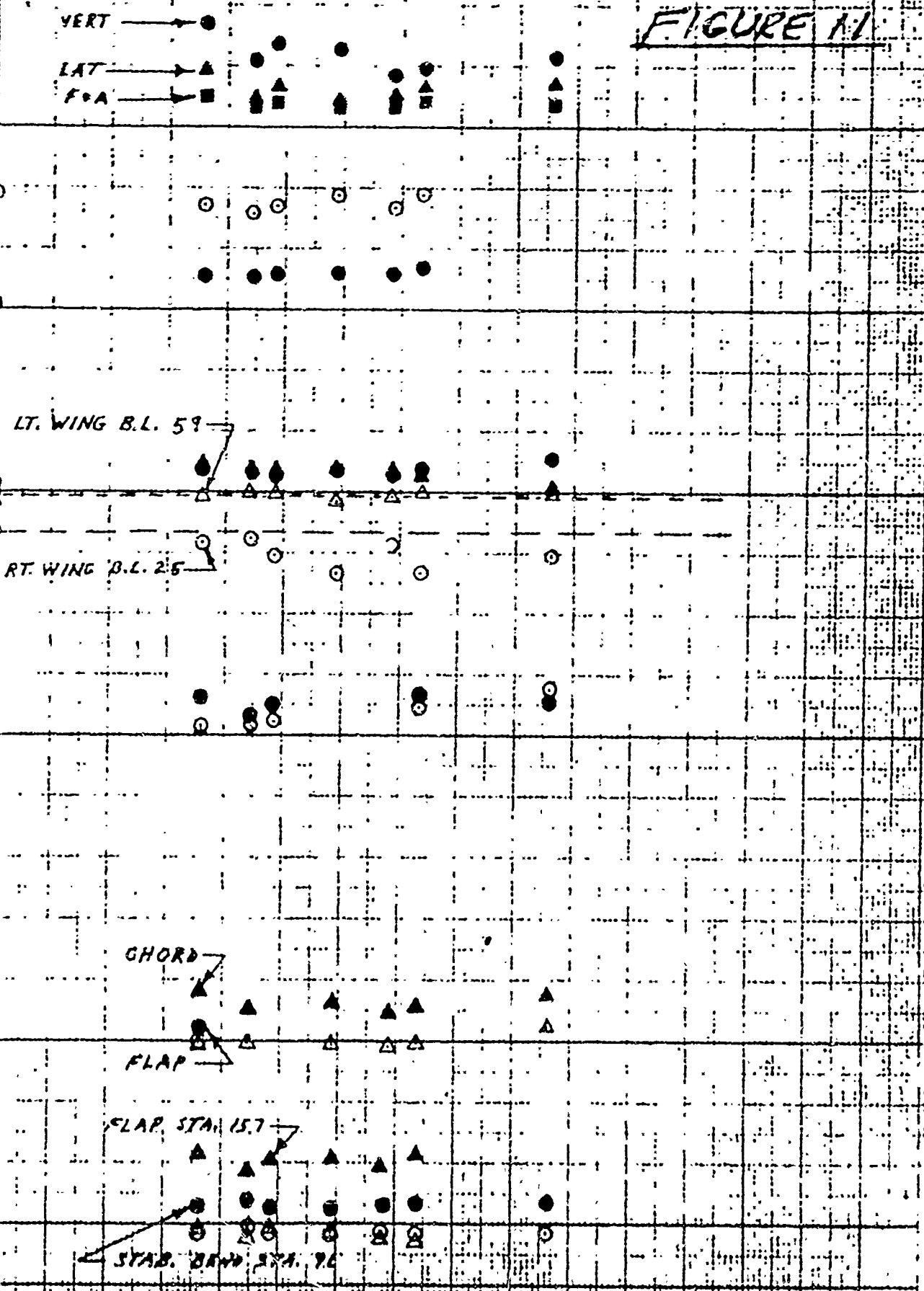
DARKENED SYMBOLS - CYCLIC  
 OPEN SYMBOLS - AVERAGE

J-60 OFF

7.57 SQ. FT. HORIZ. STAB. @ -10 DEG.

FIGURE 11

VERT  
 LAT  
 F&A  
 BLADE ANGLE  
 WING BEND  
 PITCH LINK AXIAL  
 GYRO ARM BEND  
 STAB. BEND STAB.  
 FLAP BEND STAB.



IN 3/A 1082 COMPING

LOADS & ACCELERATIONS VS. CALIBRATED AIRSPEED

4 BLADE ROTOR

J-60 10LE

FIGURE 12

DARKENED SYMBOLS - CYCLIC

OPEN SYMBOLS - AVERAGE

7.57 SQ. FT. HORIZ. STAB.  $\phi = 1.0$  DEG

HP CABIN ACCELERATIONS  
~ g<sub>ic</sub>

BLADE ANGLE  
~ DEG

WING BEND  
~ IN. LBS. x 1000

PITCH LINK AXIAL  
LOAD  
~ LBS.

GYRO ARM BEND  
STA. 13  
~ IN. LBS. x 1000

STAB. BEND STA. 157  
FLAP BEND STA. 157  
~ IN. LBS. x 1000

2

1

0

10

5

0

10

5

0

-5

400

200

0

-200

3

2

1

0

4

2

0

VERT  
LAT.  
FSA

LT. WING BL. 59

RT. WING BL. 25

CHORD

FLAP

FLAP STA. 157

STAB. BEND STA. 157

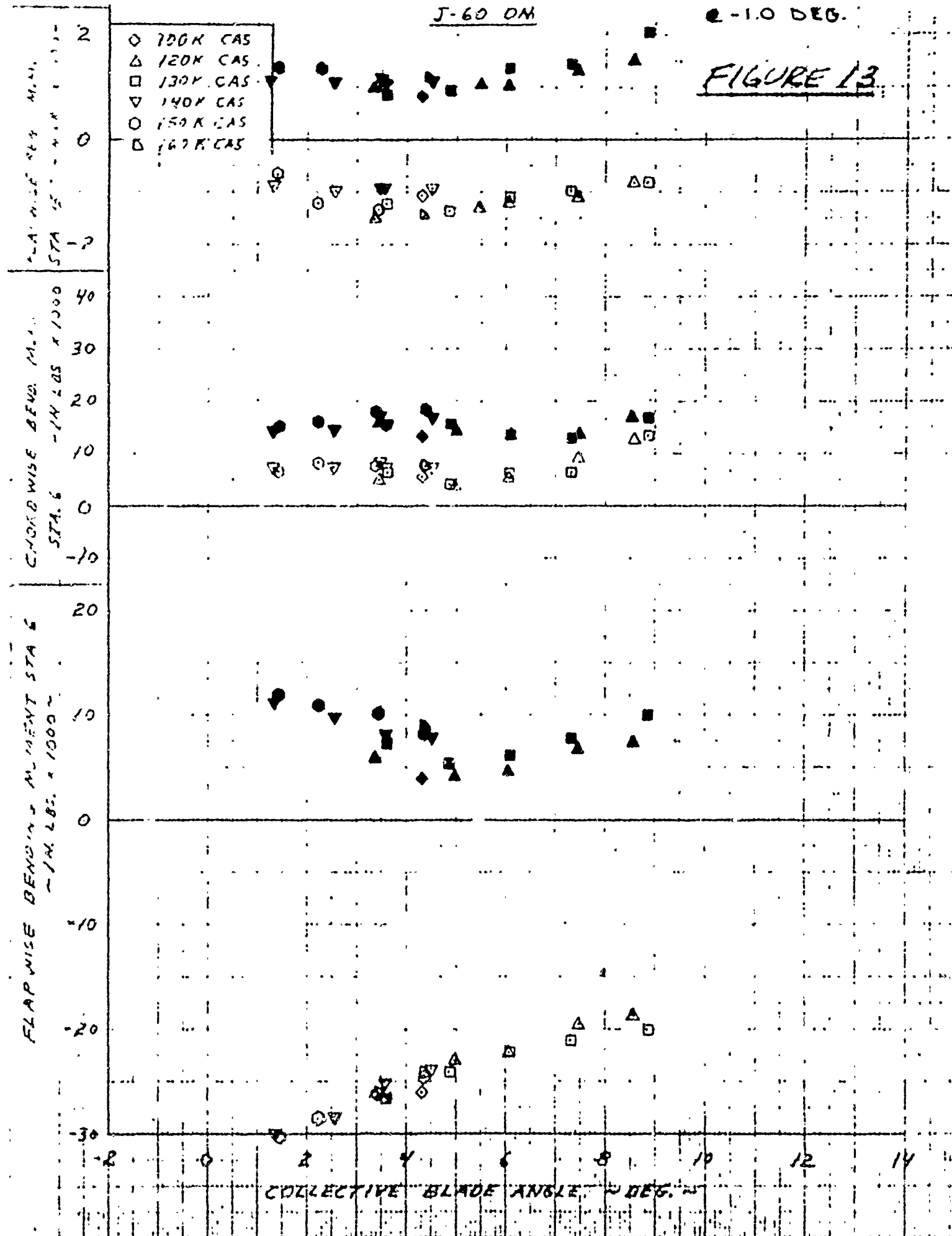
0 20 40 60 80 100 120 140 160

CALIBRATED AIRSPEED - MPH

8.7.03

IN THE ... COMPOUND  
 MAIN ROTOR BLADE LOADS VS. COLLECTIVE FLAP ...  
 4 BLADE ROTOR  
 J-60 OM  
 757 50' HORIZ. STAB.  
 -1.0 DEG.

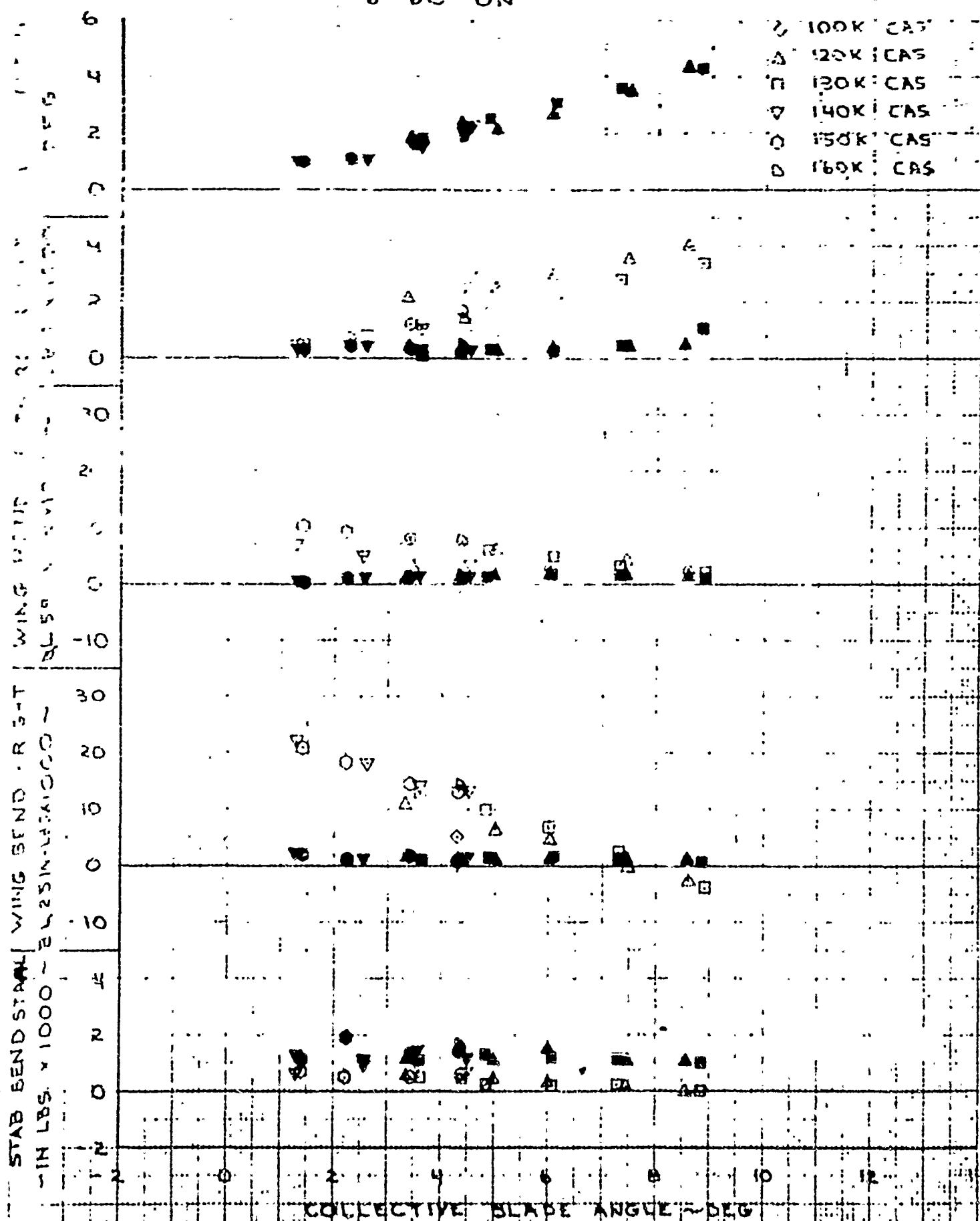
FIGURE 13



# LOADS V. COLLECTIVE BLADE ANGLE 4 BLADE ROTOR

7.57 50 FT HORIZ. STAB. A -10 DEG.  
J-60 ON

FIGURE 14



# 24-514 002 COMPOUND LOAD VS COLLECTIVE BLADE ANGLE

4 BLADE ROTOR

FIGURE 15

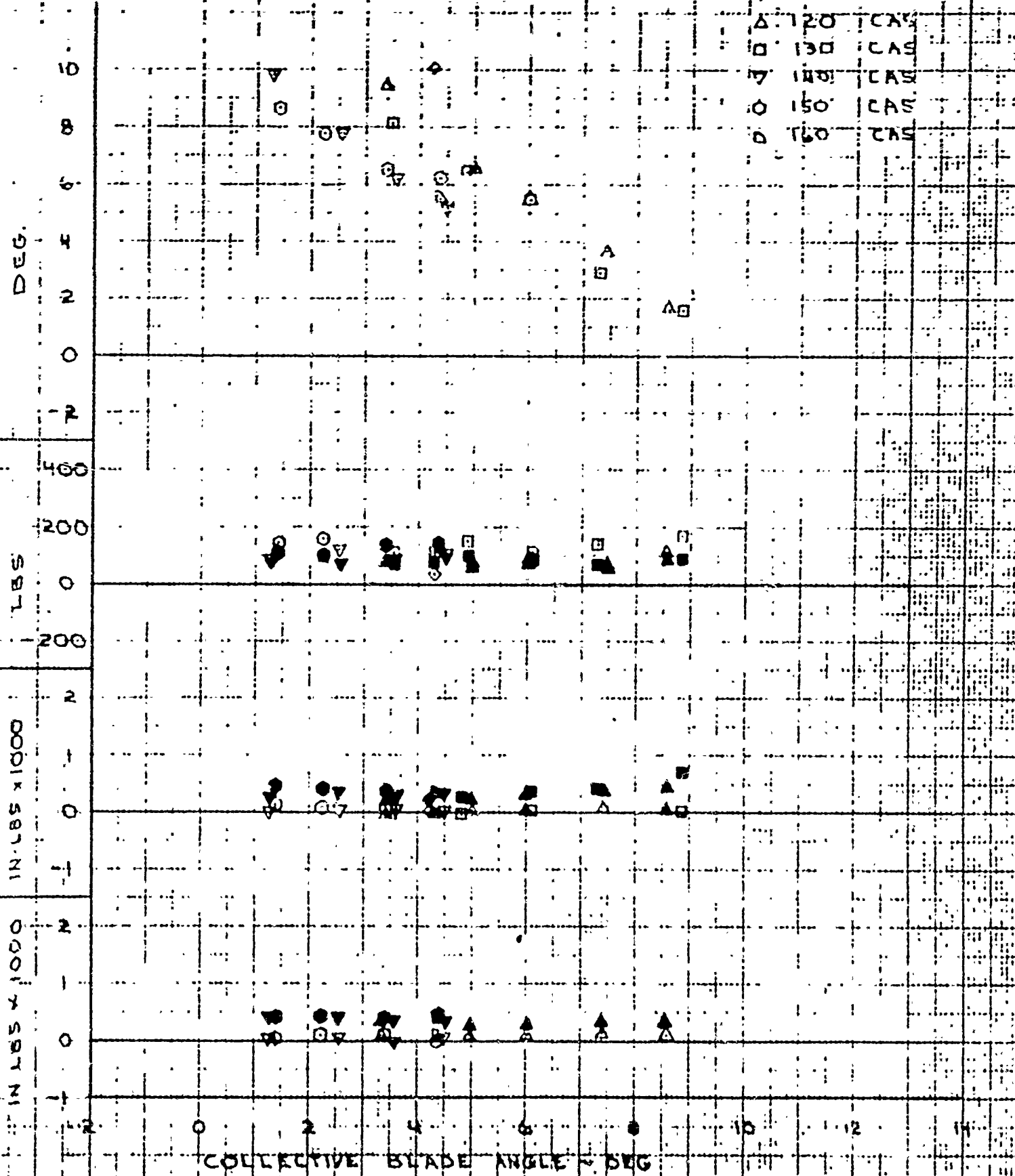
J = 60 ON 15750 FT. HORIZ. STAB.  $\epsilon = 1.0$  DEG.

- ◇ 100K CAS
- △ 120 CAS
- 130 CAS
- ▽ 140 CAS
- 150 CAS
- ◇ 160 CAS

ANGLE OF ATTACK  
DEG.

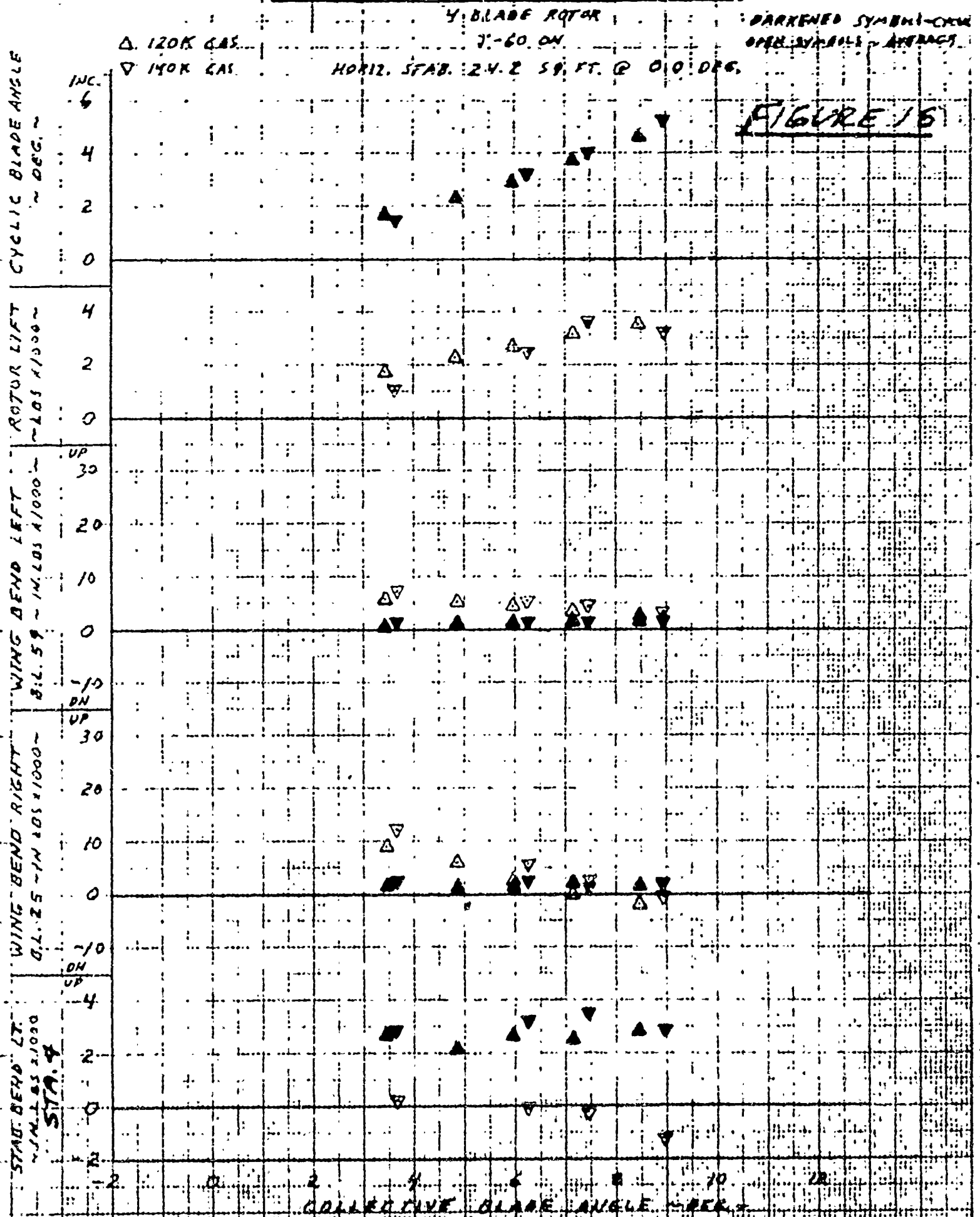
PITCH LINK  
LBS

GYRO ARM FLAP 13 GYRO ARM CHORD 13  
IN LBS x 1000



XH-51A BUNO 151263 3/4 100R COMPUND

LOADS vs. COLLECTIVE BLADE ANGLE



CHORDWISE BENDING MOMENT STA. 6

FLAPWISE BENDING MOMENT STA. 6



# MAIN ROTOR BLADE LOADS V. COLLECTIVE BLADE ANGLE

4 BLADE ROTOR

Δ 120 K CAS

J=60 ON

FIGURE 17

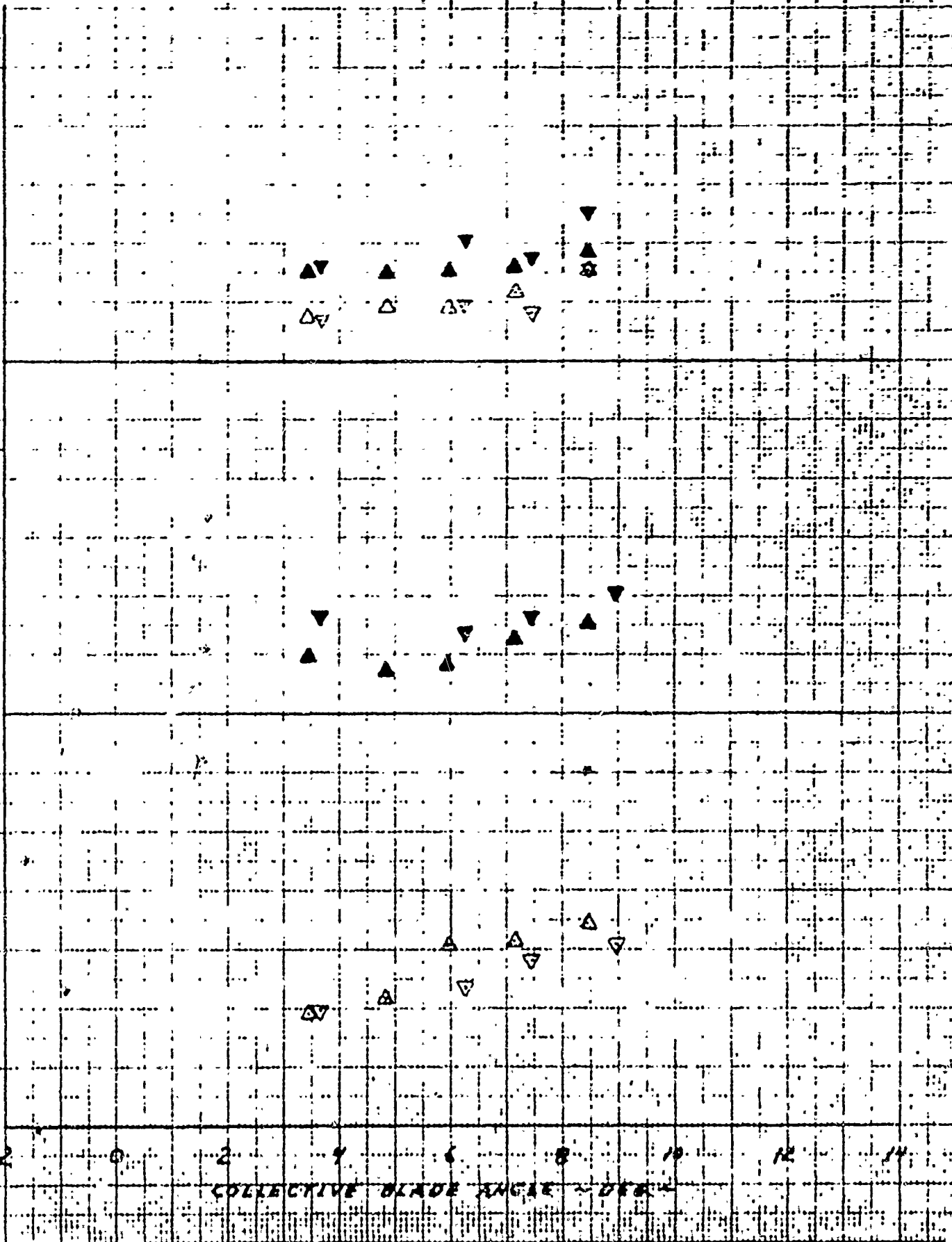
▽ 140 K CAS

HORIZ. STAB. 24.2 SQ RT 0.0 DEG.

FILLED SYMBOLS - CYCLIC  
OPEN SYMBOLS - AVERAGE

CHORDWISE BENDING MOMENT STA. C  
- IN. LBS X 1000 -  
AFT  
50  
40  
30  
20  
10  
0  
-10  
FOR  
UP  
20

FLAPWISE BENDING MOMENT STA. C  
- IN. LBS X 1000 -  
10  
0  
-10  
-20  
-30  
AH.



COLLECTIVE BLADE ANGLE - DEG

IN SIA 8-100 51263 1/4 1912 COMPOUND

# LOAD VS. COLLECTIVE BLADE ANGLE

4 BLADE ROTOR

J-80 ON

HORIZ. STAB. AREA 24.2 SQ. FT. @ 0.0 DEG

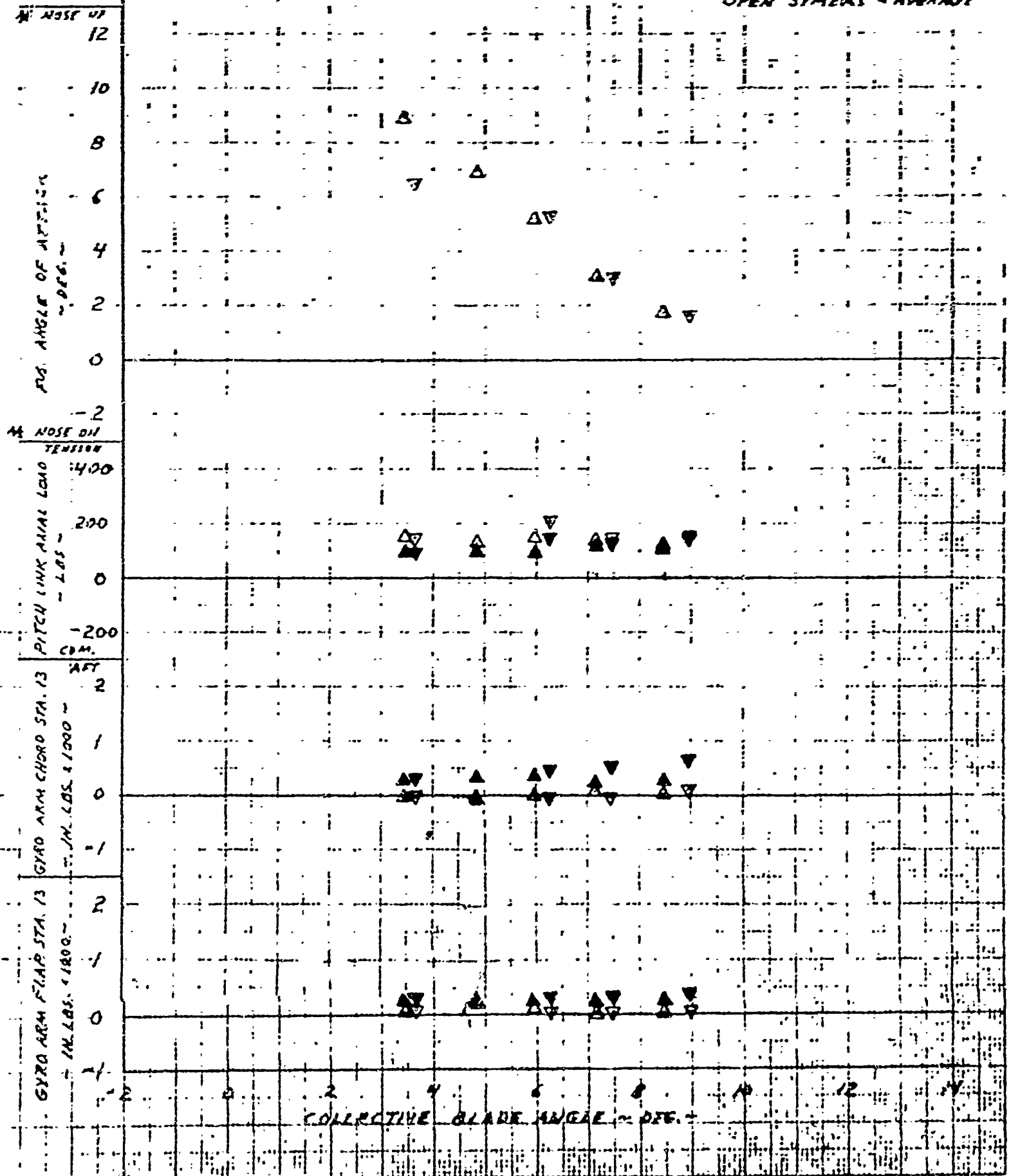
FIGURE 18

Δ 120K CAS

▽ 140K CAS

DARKENED SYMBOLS - CYCLE

OPEN SYMBOLS - AVERAGE



XH 51A - 100% COMPOUND  
MAIN ROTOR BLADE LOADS VS. CALIBRATED AIRSPEED

4 BLADE ROTOR

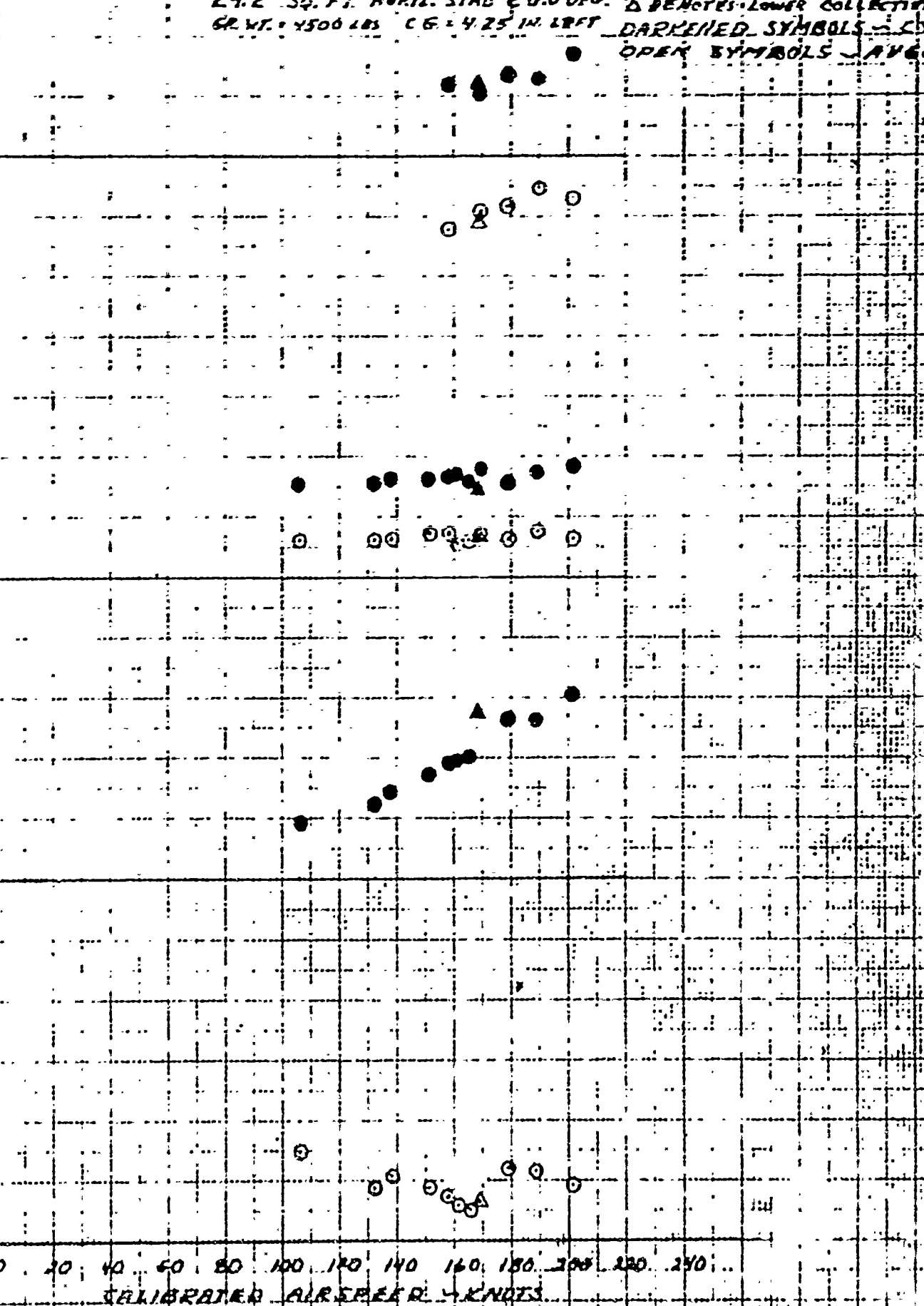
J-60 GN.

FIGURE 19

24.2 SQ. FT. HORIZ. STAB @ 0 DEG.  
 GR. WT. = 4500 LBS. C.G. = 4.25 IN. LEFT

Δ DENOTES LOWER COLLECTIVE  
 DARKENED SYMBOLS - CYCLIC  
 OPEN SYMBOLS - AVE.

FLAPWISE BENDING MOMENT STAB. C - CHORDWISE BENDING MOM FLAPWISE BEND MOM.  
 STAB. C - 1000 IN. LBS. STAB. C - 1000 IN. LBS.  
 UP  
 2  
 1  
 0  
 -1  
 -2  
 DN.  
 40  
 30  
 20  
 10  
 0  
 FWD  
 UP  
 10  
 0  
 -10  
 -20  
 -30  
 DN.



CALIBRATED AIRSPEED - KNOTS

# UH-1A 332 COMPOUND MAIN ROTOR BLADE LOADS VS. CALIBRATED AIRSPEED

## 4 BLADE ROTOR

J-ED ON.

24.2 SQ FT. HORIZ. STAB @ 0 DEG.

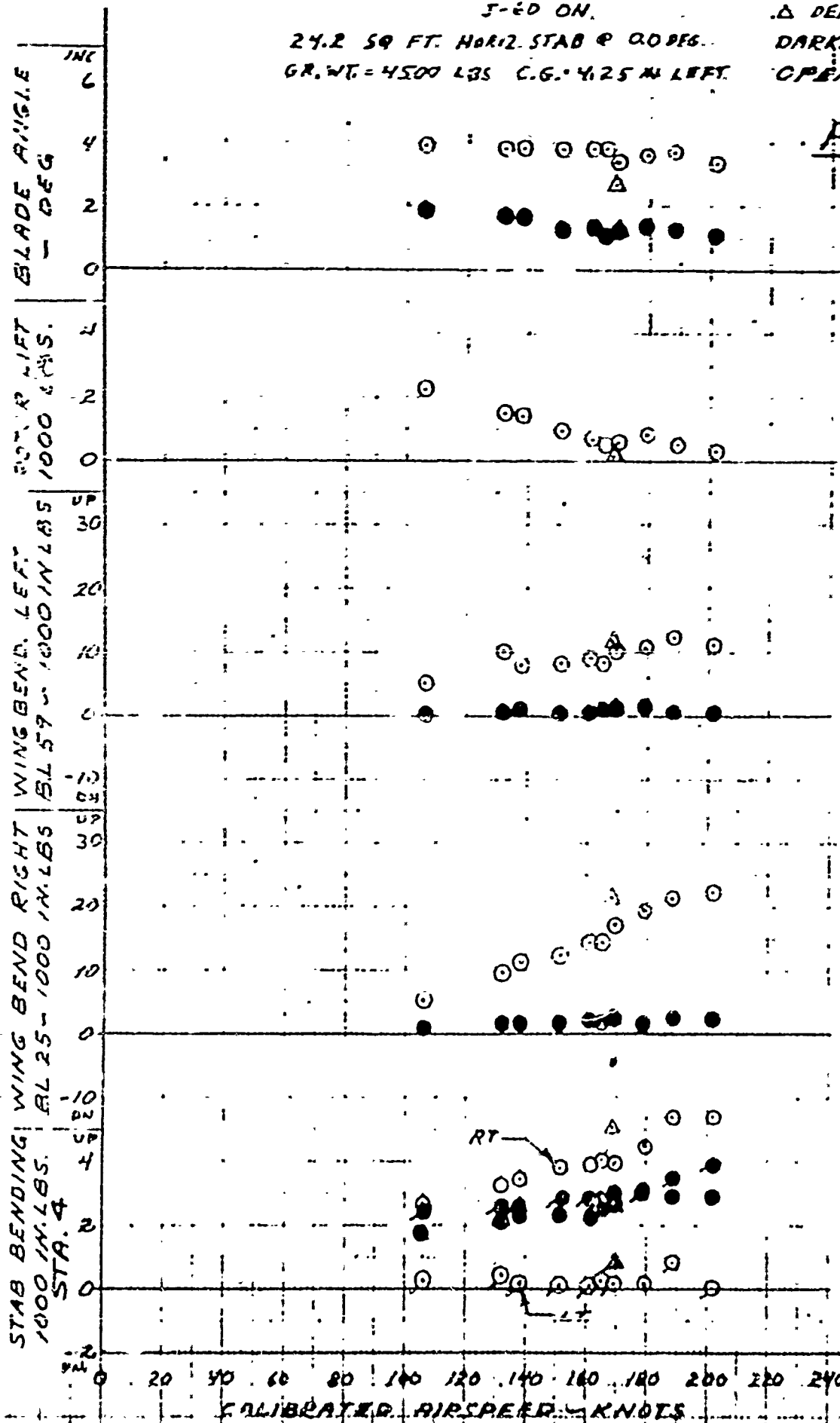
GR. WT. = 4500 LBS C.G. 4.25 IN. LEFT

Δ DENOTES LOWER COLLECTIVE

DARKENED SYMBOLS - CYCLIC

OPEN SYMBOLS - AVG.

FIGURE 20



# XH-61A - 1002 COMPOUND LOADS VS. CALIBRATED AIRSPEED

4 BLADE ROTOR

I=69

24.2 SQ. FT. HORIZ STAB. @ D.O. DEG.

GR. WT. = 4500 LBS. C.G. 14.25 IN. AFT

GYRO ARMS SET @ 30° UPTO 170 KTS

Δ WATER LOAD EFFECTIVE

DARKER SYMBOLS - CYCLE

OPEN SYMBOLS - AVG.

RESET TO 4.2 @ 170 KTS UP

FIGURE 21

ARM N. UP  
12

10

8

6

4

2

0

2

4

6

8

10

12

14

16

18

20

22

24

26

28

30

32

34

36

38

40

42

44

46

48

50

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554

TAIL ROTOR FLAP BEND STA 19.5 vs CALIBRATED AIRSPEED

4 BLADE ROTOR

J-60 OH

FIGURE 22

HORIZI. STAB. AREA 24.2 SQ. FT. @ 0.0 DEG.

GR. WT. 4500 LBS C.G. 4.25 IN. LEFT

DARKENED SYMBOLS - CYCLIC

OPEN SYMBOLS - AVERAGE

Δ ORNOTES LOWER COLLECTIVE

PUSH TO RT

1000

800

600

400

200

TAIL ROTOR FLAP BEND STA. 19.5  
- IN LBS.

M.R. 3 BLADE  
DATA AVE.

← CYCLIC

0 20 40 60 80 100 120 140 160 180 200 220 240  
CALIBRATED AIRSPEED - KNOTS

YN-51A BUND 151263 SIN 102 COMPARE

# ROLL & PITCH COMPONENT V. CALIBRATED AIRSPEED

4 BLADE ROTOR.

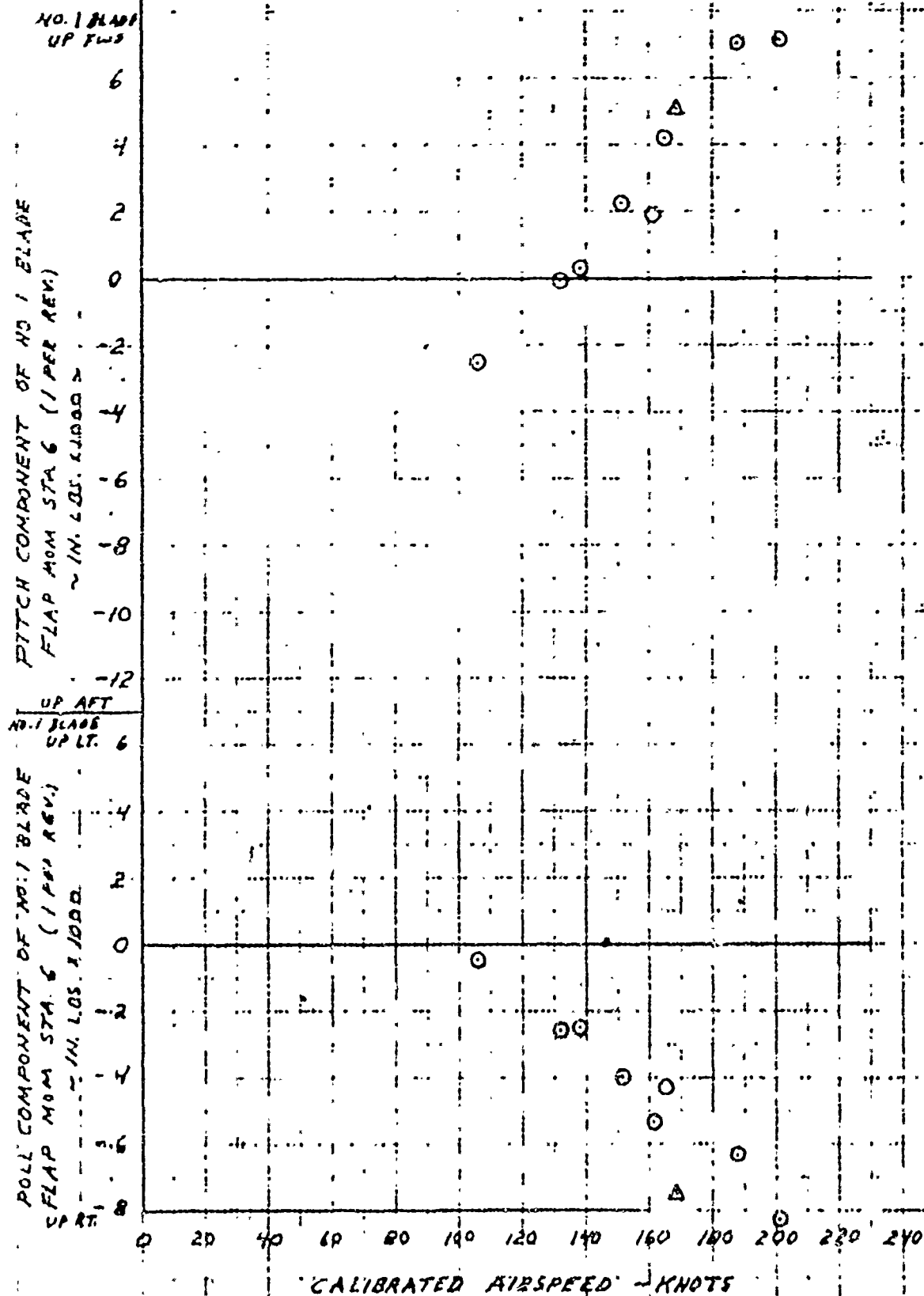
24.2 SQ. FT. HORIZ. STAB. @ 0.0 DEG.

GR. WT. = 4500 LBS. C.G. = 4.25 IN. AFT

Δ DENOTES LOWER COLLECTIVE

J-60 ON

FIGURE 23



XH-51A BUNO151263 S/N 1002 COMPOUND

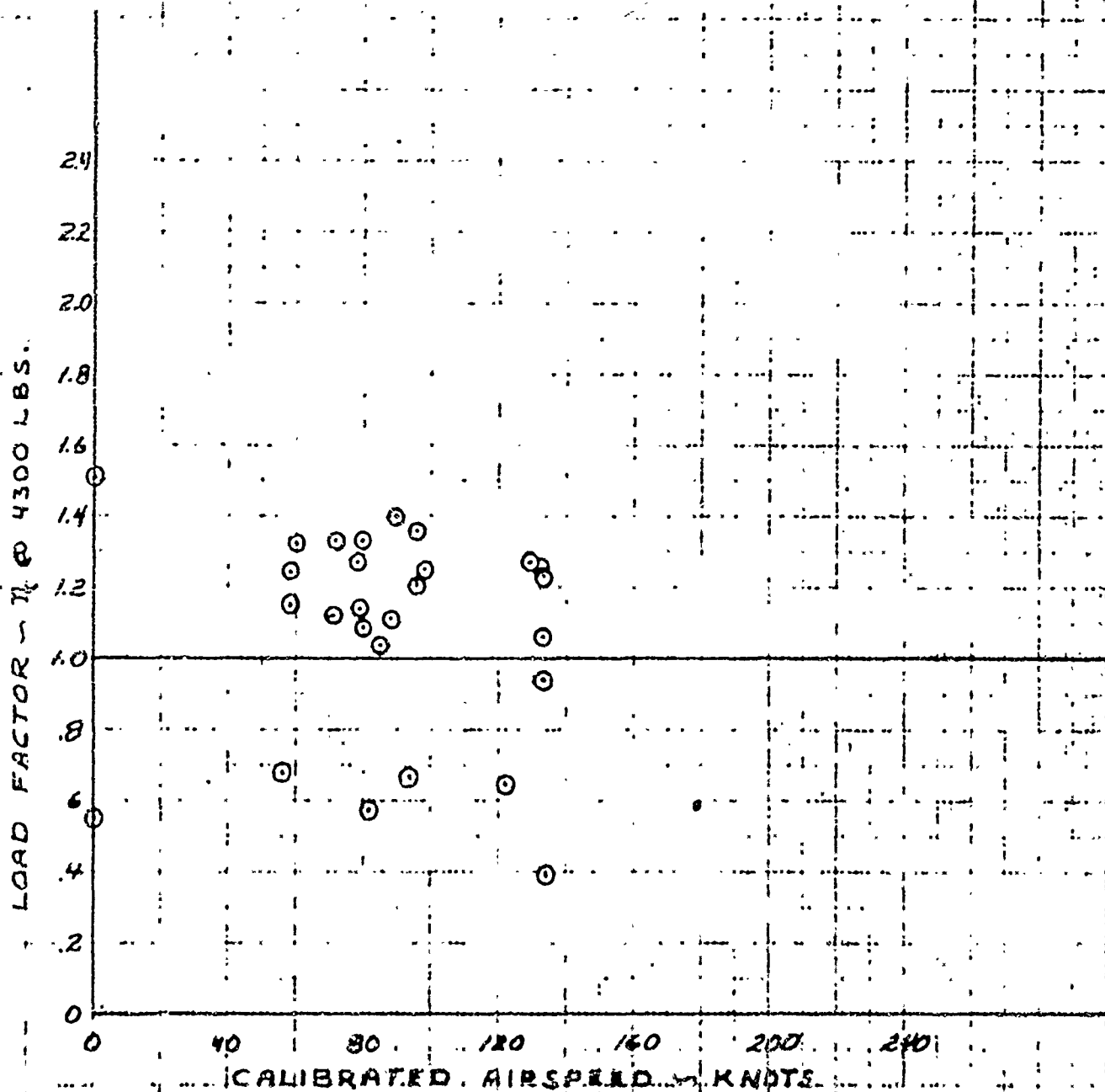
V-N DIAGRAM

GROSS WT. - 4300 LBS.

C.G. - 28 IN. FWD. - 44 IN. LT.

J-60 OFF

FIGURE 24





XH-51A BUH0151263 SYN 100R COMPOUND

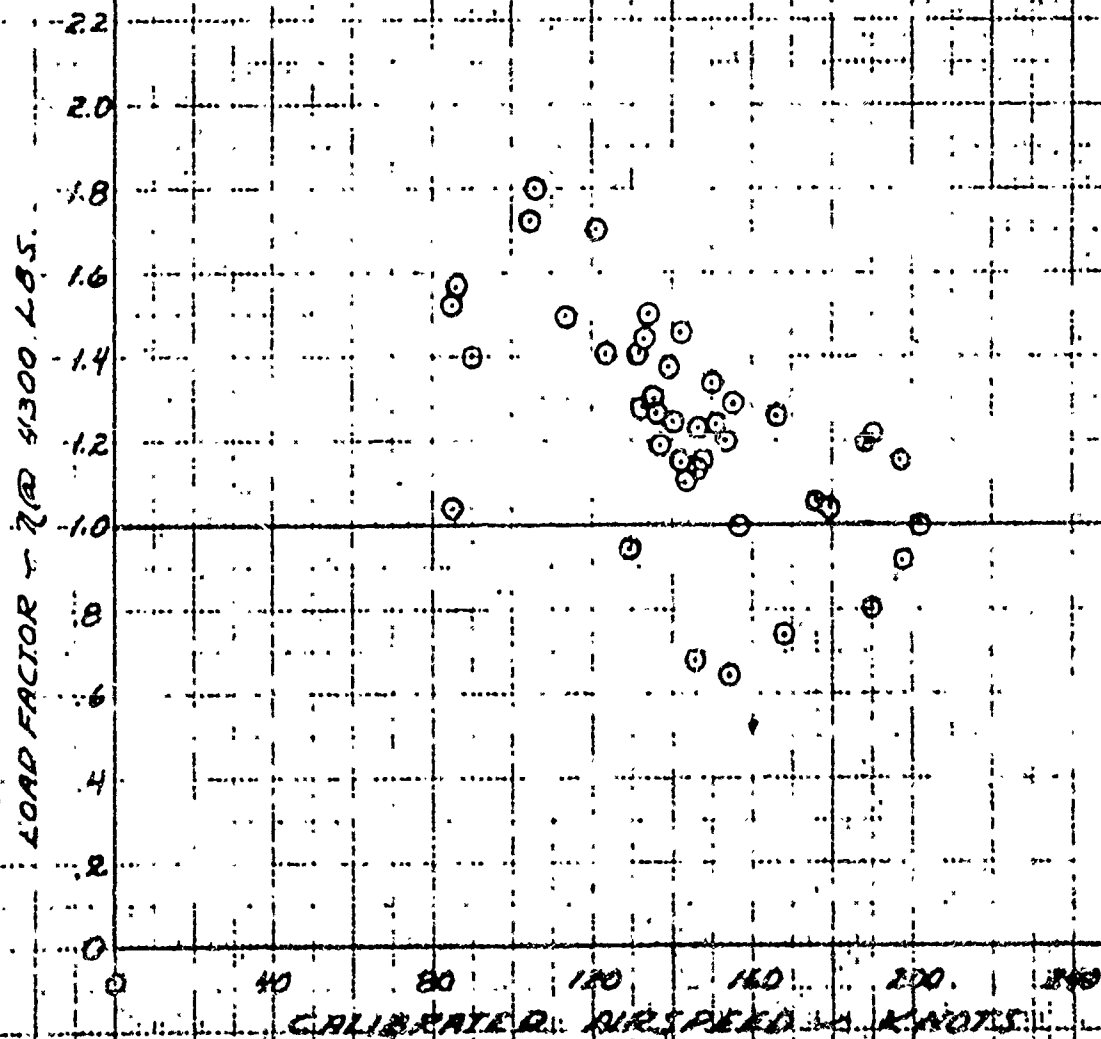
V-N DIAGRAM

GROSS WEIGHT - 4300 LBS

C.G. - 42.5 IN. LEFT

J-60 ON

FIGURE 25

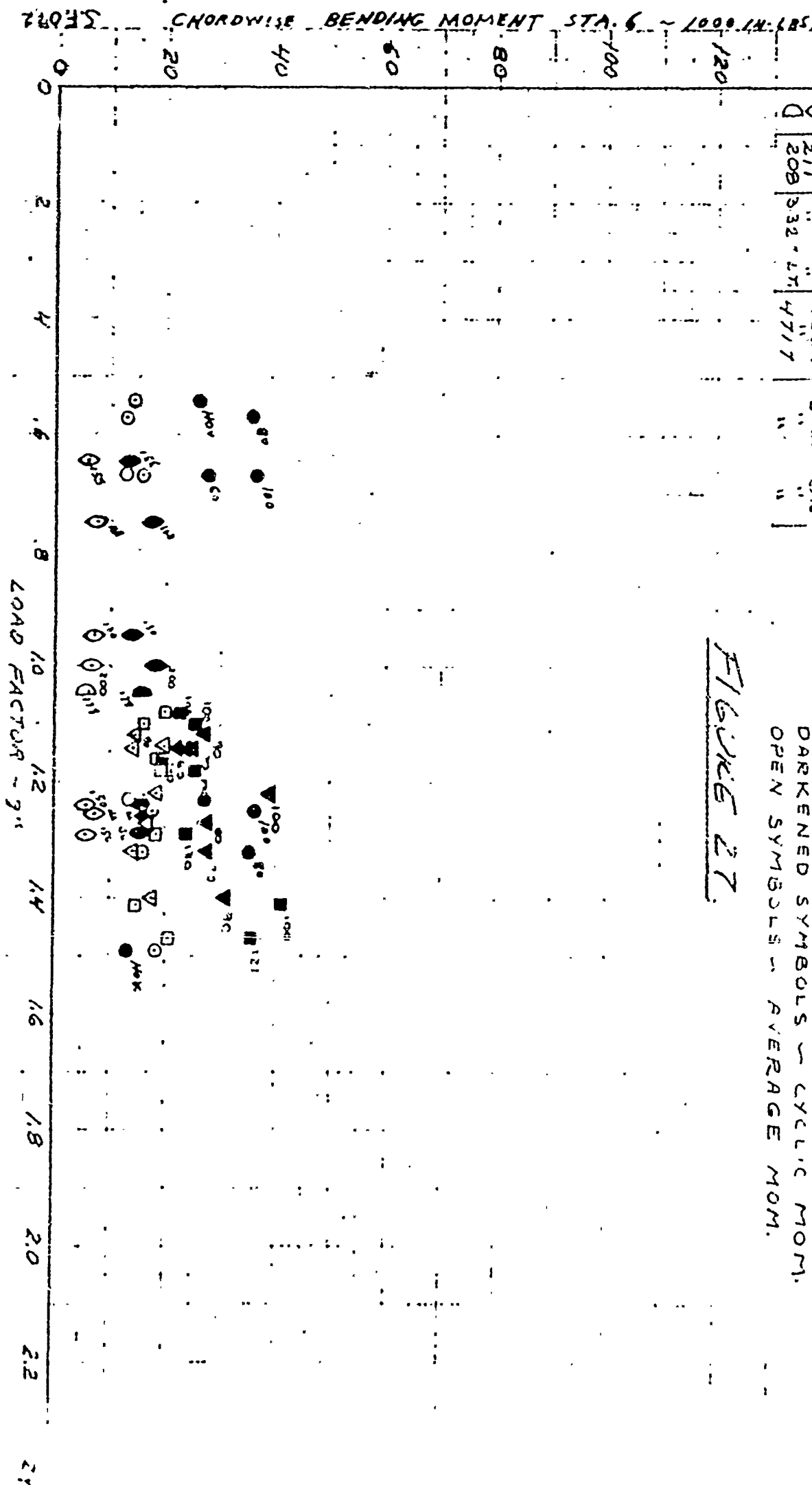


STATION	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4
LOAD FACTOR - 9"								

SYNTEST	C.G.	T.O. NT	M.P. CHORDWISE BENDING MOMENT STA 6 IN LOAD FACTOR	4 BLADE ROTOR
175	85.444	436.8	3.60 OFF	
180	"	"	"	
203	42.5	44.8	5.60 10LE	
210	47.4	45.8	5.40 5N	
211	47.4	47.7	"	
208	47.4	47.7	"	

Figure 27

DARKENED SYMBOLS - CYCLIC MOM.  
OPEN SYMBOLS - AVERAGE MOM.



FLAPWISE BENDING MOMENT ~ 1300 IN. LBS.

220.13

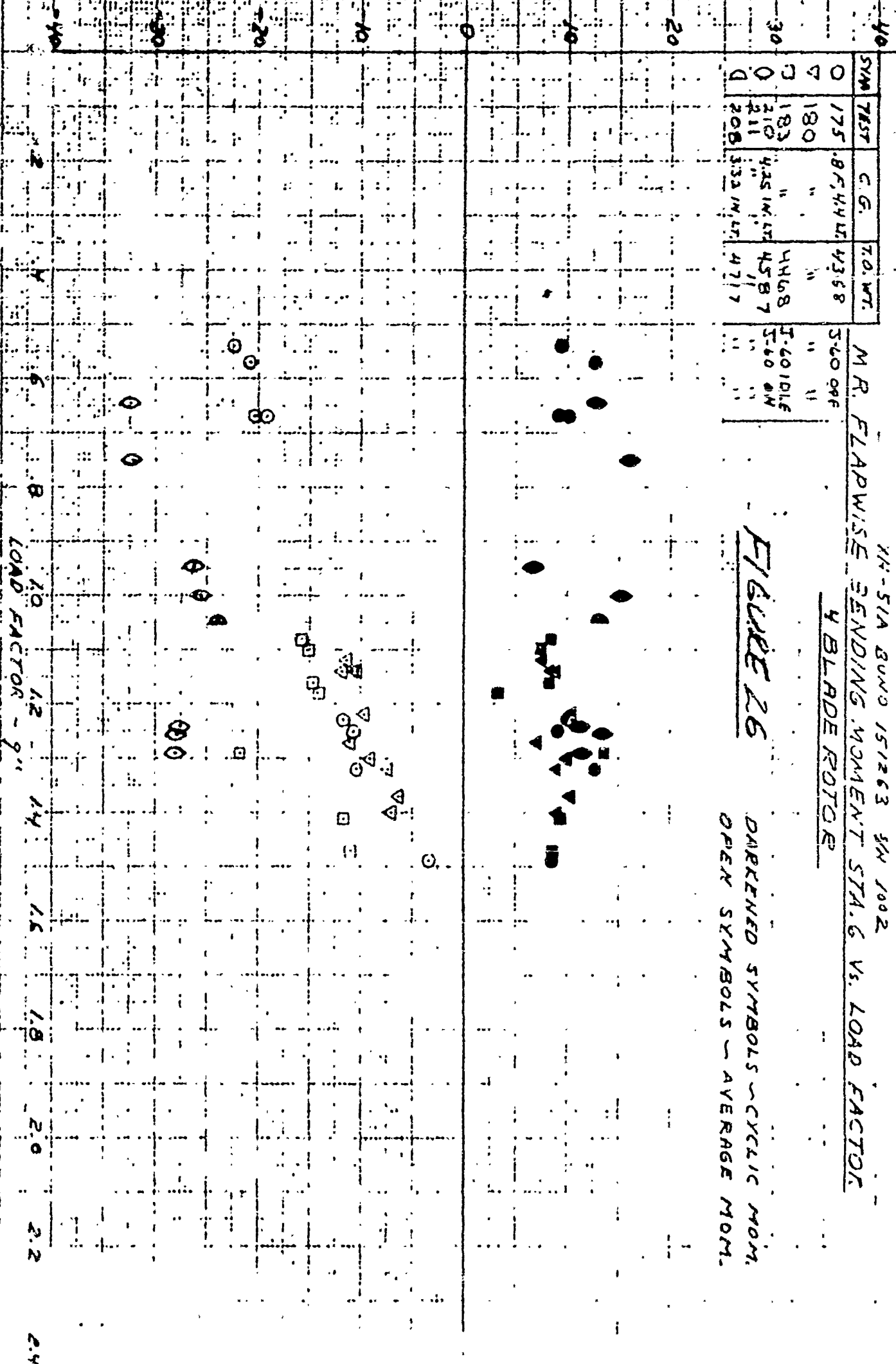
SYM	TEST	C.G.	T.O. WT.
0	175	87.44 IN.	4368
7	180	"	"
7	183	"	4468
0	210	43.5 IN.	4587
0	211	"	"
0	208	33.2 IN.	4717

M.R. FLAPWISE BENDING MOMENT STA. 6 VS. LOAD FACTOR

4 BLADE ROTOR

FIGURE 26

DARKENED SYMBOLS - CYCLIC MOM.  
OPEN SYMBOLS - AVERAGE MOM.

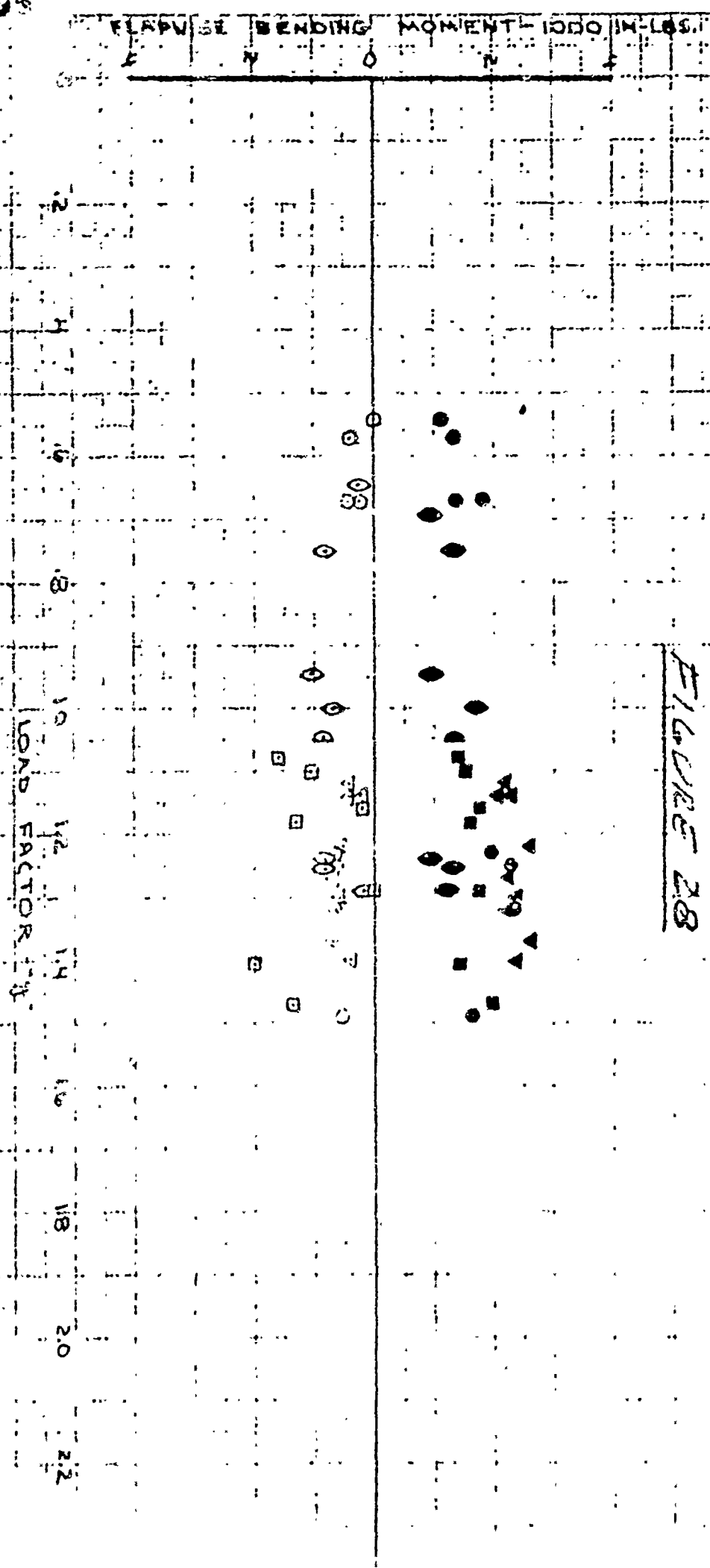


XH-SIA BUNO 151263 SIA 1002 COMPOUND  
MR FLAPWISE BENDING MOMENT STA 157 V. LOAD FACTOR  
H1 BLADE ROTOR

SYM	TEST	C.G.	TQ. WT.	
○	175	8 IN. FWD. - 4.4 IN LEFT	11.123	J-60 OFF
▽	180	8 IN FWD. - 4.4 IN LEFT	43.68	J-60 OFF
□	183	" " " "	44.68	J-60 10LB
○	211	4.25 IN. LEFT	45.87	J-60 ON
○	208	3.32 IN. LEFT	47.17	" "

DARKENED SYM.~ ILLIC MOM.  
OPEN SYM.~ AVERAGE MOM.

FIGURE 28



XH-51A BUNO 151263 4N1002 COMP.  
CABIN VIBRATIONS VS. CALIBRATED AIRSPEED

4 BLADE ROTOR

FIGURE 29

○ VERTICAL @ PILOTS SEAT ~ 4 PER REV.  
 \* HIGHER

ACCELERATIONS - PEAK G'S

1.0  
0.8  
0.6  
0.5  
0.4  
0.3  
0.2  
0.1  
0

0 20 40 60 80 100 120 140 160 180 200 220

CALIBRATED AIRSPEED - KNOTS

